

Edgar F. Bryant

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REPRINTED FROM THE AMERICAN JOURNAL OF ORTHOPEDIC SURGERY
MAY, 1912.

PRINTED FOR THE AUTHOR.

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ON THE EXERCISE TREATMENT OF PARALYSES.*

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The great amount of splendid work which has been done during the last ten or twenty years for the relief of paralyzed patients by devising ingenious operative methods and inventing mechanical apparatus has largely improved the prognosis of conditions which have previously been so pitiful. But with all this work in which the orthopedic profession of this country has taken so large a part, the older conservative methods have not by any means come to a standstill. This is especially true of the exercise treatment of paralysis, which has been constantly developed and improved as the modern literature shows. Experience in our clinics, however, demonstrates that in practice the value of this method is not so clearly recognized and that it is not so much employed as it deserves. Many of the patients who come to us have not been treated at all or only to an insufficient extent. Some of them stated that their physicians considered their cases hopeless and that nothing could be done for their relief. This therapeutic nihilism is not justifiable; the longer we follow this line of treatment, the more we feel in favor of it, as it has given us such satisfactory results and at times improvement which was quite unexpected.

The exercise treatment is only one part of the stimulative methods, to which belong also electricity and massage. All three methods should be and are used in our hospital in a rational combination, but I personally do not doubt, and I am in agree-

*Read by invitation before the American Orthopedic Association, at its Twenty-fifth Annual Meeting, held at Cincinnati, May 15-17, 1911.

ment with most competent authors, that the exercise treatment furnishes the largest possibilities for an actual improvement. Although the orthopedic surgeon is not equally interested in all forms of paralysis, I wish to give a report of a variety of cases, because the main principles of their treatment are equally applicable to all forms. Since this paper is of a general practical interest we have omitted exhaustive outlining of the theories which are offered by neuropathologists for the explanation of the action of this form of treatment. We shall only state the various reasons and indications for the treatment, (1) we shall deal with the technic, (2) and give a report of our cases, (3) especially those which have been under treatment a sufficiently long time to enable us to arrive at some definite conclusions.

Analyzing the various indications, we have to consider the effect of the treatment on

1. The primarily affected neurons,
2. Those neurons
 - a. which are in a functional connection with the former and
 - b. those which furnish possibilities of substitution for the destroyed parts,
3. The musculature,
4. a. The joints,
- b. The bones,
5. The internal organs and general health, and
6. The mind of the patient.

I.

INDICATIONS.

1. The first question, that of the influence of the treatment on the primarily affected neuron, is the most difficult one to explain. It is quite certain that a completely destroyed neuron will never regenerate, but in practice it is frequently very difficult to decide to what extent the neurons are affected. This is especially true soon after the onset, as is so well illustrated by the course of infantile spinal paralysis. While in many cases no further re-

generation takes place after six to twelve months, in others this period of regeneration may be much longer. There are indeed patients who finally show power in muscles which have been apparently completely paralyzed for more than twelve months. This was noticed in our Cases IV and IX.

Clinical observations suggest that carefully treated cases make better progress than those which are not treated, so that we may fairly suppose that this treatment has an actual influence on the regenerative process, though this has not yet been definitely proved.

2a. In the treatment of paralysis, however, as well as in some other disturbances of the nervous system (as tabes), it is not only the primarily affected neuron which is to be treated, but also all those neurons which are in a functional connection with it.

A voluntary motion is a very complicated process and needs the coöperation of many different neurons: the motor neurons which lead stimuli from the cortical motor centers to the peripheral nerves, the associative neurons, which furnish the connection of the various cerebral centers, and also the sensory neurons of muscles and joints, which by their action enable the brain to control the correct performance of the movement. All of these suffer from lack of activity when one of them is injured; they suffer in a different degree in the different diseases, but to a certain extent in all of them.

To *Leyden* and his pupils *Goldscheider*(7. a. 8), *Jacob*(8), *Lazarus*(10. a. 11), and others, who have greatly improved the exercise therapy of paralysis and other disturbances of the nervous system, we are indebted for the inauguration of rational theories on the influence of functional stimulation of the neurons. *Goldscheider's* ideas on this subject in his classical book, "On the Importance of Stimuli in the Light of the Neuron Theory," and the ideas in *Jacob's* article in the "Handbuch für physikalische Therapie" are briefly as follows:

The stimulated condition of a neuron which is produced by any adequate stimulus, provided this is above the stimulus threshold, acts in turn as a stimulus on the contact neuron, provided the neuron is sufficiently stimulated, or as *Goldscheider*

says, the stimulus is above the neuron threshold. Furthermore, a stimulus which is not able to bring a stimulated condition so far that it is above the neuron threshold or that it has no actual effect prepares the way for the following stimulus, so that the latter may overcome the resistances given by passing through the neuron and passing over to the next neuron. In this way may be explained the greater effect of cumulation of stimuli. These resistances are not of an equal value, but are subject to a considerable change according to the amount and character of stimuli which pass along the neurons. Goldscheider speaks of a lowering of the neuron threshold and says that in like manner as we notice at times a very marked lowering of the peripheral stimulus threshold so we have reason to suppose that similar conditions are present in the relation of the various neurons in the neuron threshold. On the other hand, by the lack of appropriate stimuli the neuron threshold is raised and the resistances are increased, but by furnishing appropriate stimuli a lowering of the threshold may take place again, provided the anatomical lesion is not too severe. If we consider those theories to be true we know of no way in which the neuron threshold can be so well lowered as by a rational exercise treatment.

2b. The theories above enunciated help us further in understanding the recovery in cases of cerebral paralysis where, as is supposed, substitution of other neurons for the destroyed ones takes place. The clinical and experimental observation of *Lazarus*(11),* *Foerster*(3. a. 4.), *Faure*(2), and others lead to the conclusion that when the pyramidal tracks are destroyed on one side the subcortical centers and the associative neurons of the same hemisphere, as well as parts of the other hemisphere, may to some extent take their places. These new paths are rough, their neuron thresholds are high. Nature has on hand certain resources for preparing the new tracks, but this natural power is usually too small. A real education, a supply of repeated adequate stimuli by exercise treatment, is necessary to take full advantage of these unused storehouses of nervous energy.

3. The third point to be considered is the training of the mus-

* See further references to this point in *Lazarus'* article (11).

cles. The influence of exercise on the muscle is important in two different ways: (1) It builds up the muscular tissue, as is so well shown in the hypertrophy of muscles in athletes. (2) It increases the power and the endurance of the muscle along with the increase of the muscular tissue, although not in a constant relation to it.

It must, however, be constantly borne in mind that with the increase of muscular tissue and of muscle power which these exercises provoke, there is also necessarily a favorable influence exerted on the nerves supplying their muscles.

Special indications for muscle training are given in such cases of anterior poliomyelitis or peripheral paralysis where we have to deal with a partial paralysis, for the following reason. In most parts of the body the muscles are arranged in such a way that if one muscle is paralyzed, another may take its function to some extent and this substitution is at times surprisingly good. We must, therefore, study each case carefully and try to find out how great the possibilities of restoration are from this point of view, striving to strengthen those muscles which can be substituted for the paralyzed ones.

4a. The next point to mention is the influence of exercise therapy on the condition of the joints. It would lead us too far to discuss thoroughly the various forms of articular complications with which paralytic patients are so frequently afflicted. One of the chief indications for exercise treatment is to prevent contracture and stiffening of joints, although frequently the assistance of mechanical appliances, as braces or casts, is needed. The real value of preventive measures is too frequently underestimated, because it is impossible to say in a single case whether without appropriate treatment complications would appear or not, but the clinical observation of a great number of cases makes us certain of the results which we have obtained. I regret that our material does not give us much opportunity to demonstrate that preventive effect of exercises, because most of the patients come to us rather late in the course of the disease, with more or less marked contractures. In cases of minor degree of contracture the exercise treatment is at times

sufficient to restore the passive mobility, while in graver cases surgical intervention is necessary.

Frequently the restoration of the function of paralyzed limbs depends not only on the relief of the paralysis, but also on the cure of the mechanical obstruction of one or several joints. In such cases exercises are indispensable, although operative measures are at times indicated.

Older patients with hemiplegia are likely to acquire arthritis deformans. A slight amount of gentle exercise may avoid arthritic processes, or when they are already present may at least favor a partial restoration of the passive function, provided the pathological changes are not too severe.

4b. Of importance is the influence of exercise on the development of the bones in paralyzed limbs of growing individuals. In cases of cerebral hemiplegia in children we frequently notice a distinct underdevelopment of the affected arm which at times shows a considerable shortening of all bones, while the affected leg does not show any such lack of development. This may be explained by the fact that the leg naturally receives much more functional stimulation than the arm. If not especially trained, such children learn to do most of the necessary work with the healthy hand and are not anxious to make a sufficient use of the paralyzed hand, while the leg takes care of itself. My experience is still too small to enable me to state definitely as to whether the amount of stimulation produced by exercise treatment will be sufficient to compensate entirely for the effect of the paralysis on development, but it seems as if this clinical observation teaches us very clearly the probable advantage of the best possible training by means of stimulated exercises.

5. The value which exercises exert upon the general health and upon the development and action of the internal organs in these paralytic cases is practically the same as in normal individuals. There are, however, some points especially worthy of consideration in paralytic patients. It is obvious that patients with any considerable amount of paralysis, especially of the lower extremities, suffer from lack of exercise. Children under such conditions are usually not able to get as much out-of-door exercise as

their fellows. The consequence is that many of them are retarded in their general development and less resistant to disease and to the demands of life. This is especially true among the poorer classes.

Perhaps of still greater importance is the question of proper exercises for paralyzed adults. The difficulty which these patients have in moving about frequently induces in them a dangerous amount of idleness, the more dangerous as in most of these cases the vascular system is damaged. The muscles of the vessels require a certain amount of stimulation and work for the performance of their proper functions, and the effect, therefore, upon the general metabolism must at once be evident. It is hardly necessary to mention that in all cases with advanced arteriosclerosis any overexertion is strictly to be avoided.

6. Among the various other good influences which exercises exert on our patients not the least important is that on the mind. Everyone knows the stimulating and refreshing effect which regular exercises or sports produce. Paralyzed patients are usually not able to enjoy sports and games as do normal persons. Nevertheless they are very thankful when they have opportunity to engage in exercises, which, considering their conditions, play for them the same rôle as do sports in normal individuals. It is certainly striking to observe how many paralyzed patients show very marked improvement in spirits and in enjoyment of life, even out of proportion at times to the physical improvement. We have not rarely made such observations even in the most hopeless cases with patients who were no longer under their physicians' care because of the absolutely unfavorable prognosis which had been given. This has convinced us that exercise treatment should not alone be regarded from the point of possibility of improving the paralytic condition itself, but should be considered an end in itself.

It seems to us a great cruelty to tell a patient, especially one who is young and is looking forward perhaps to a long life, that his case is absolutely hopeless, when it may be possible to do so much for him, both physically and, I think we may say, spiritually as well.

I have tried to show of what great value exercise treatment is for the paralytic patients in general, but there are several points which make it of special importance for the orthopedic surgeon to supervise and if possible to carry out such treatment himself. By doing this he will not rarely bring the patient into a condition better fitted for a tendon transplantation, and furthermore he will by continuing exercises after the operation obtain better results.

Lovett(12), in his article on "The Treatment of Paralytic Deformities," speaks of the exercise, or as he calls it, the developmental treatment, which is advisable after tendon transplantation. After mentioning electricity and massage, he concludes, "Muscle training is coming to occupy the prominent place in our therapeutics that it deserves and is superior to either of the two measures mentioned." "As a therapeutic measure it has the advantage of directness in being exactly what the muscle has got to do in restoring or improving function."

Biesalski(1), while not belittling the ingenuity of *Foerster's* operation on the posterior nerve roots, considers that the results reported are due in great part, perhaps almost entirely, to *Foerster's* splendid system of treatment by educational exercises which follow every operation.

II.

TECHNIC.

The various indications which we have considered should be taken into account when planning the treatment. Especial emphasis should be laid on the following points:

1. That it is not wise to prescribe exercises in a general way and leave it for the parents or the masseur to attend to the details.
2. That the physician must study the cases thoroughly himself.
3. That he must know to what extent the nerves and muscles are affected.
4. That he must consider not only the mechanical possibilities of the affected joints and muscles, but must also pay attention to the general condition of the patient, both mentally and physically.

With these points in mind the physician must work out a comprehensive plan for the treatment which is to be followed by his trained assistant or by the parents of the patient, provided he is not able to do it himself. The importance of teaching the lay operator the true spirit of the exercise treatment cannot be too strongly emphasized. The mere prescription of, for example, "flexion and extension of the elbow twenty-five times and elevation of the arm twenty-five times, etc.," is not sufficient. It is of prime importance that the operator learns to avoid injury to the delicate nerves, muscles and joints. He must learn patience as well, and must understand that success will come but slowly and that immediate results cannot be expected.

Although it was said in the introduction that the general principles of exercise treatment apply to all forms of paralysis, its application varies to some extent with each case, according to the nature of the disease, the duration of the paralysis, and the general condition of the patient. It is especially in regard to the neuromuscular apparatus that different kinds of manipulation are necessary. The method of treatment in cases of paralysis where the motor endneurons are primarily affected is quite different from that in those which show a primary involvement of the central neurons.

As types may be considered anterior poliomyelitis and cerebral hemiplegia. In anterior poliomyelitis the most competent authors agree that during the first three to four or even eight weeks stimulations should be entirely avoided and should be used for the following two to three months only with great care. I should like to add that special care of the neuromuscular apparatus is necessary during the whole treatment in all those cases where the peripheral motor neurons are primarily affected, in order that no harm be done.

Owing to the grave changes in the muscles the tension of the muscular tissues requires especial consideration. It is a clinical fact that sometimes paralyzed muscles recover more quickly and easily when an apparatus is applied which causes the muscles to remain in a shortened position, or when a tenotomy of the contracted antagonistic muscles is performed. This observa-

tion teaches us to avoid unnecessary tension while exercising the muscles. Therefore, we lay special weight (1) on the prescription of the position in which the limb is to be held in performing the exercises; (2) on the angle through which the exercise is to be carried out, and (3) on the support which is given to the limb and the neighboring parts while this is being done. This is especially important for those cases where signs of recovery are seen, but should also be considered in giving passive exercises to a group of muscles which is for the time being completely paralyzed.

1. Although with the patient in any position a correct exercise may be carried out, the following principles have been found useful in our own experience. Usually we bring the resting part of the body in a horizontal and the moving part in a vertical or nearly vertical position, because according to the law of levers the weight of the latter is mostly reduced in the vertical position, and better control of the movement is obtained.

A few examples may illustrate this point:

a. The elevation and rotation of the arm are performed with the patient lying on his back.

b. For extension and flexion of the elbow the humerus is horizontally supported and the forearm moved in a vertical direction.

c. The extensors of the wrist are exercised with the forearm held in half or full supination and not in pronation, for in pronation danger exists that the small amount of power which may be present in the extensor muscles cannot be utilized, and the only effect is a stretching of the muscular tissue.

d. The muscles of the knee are exercised while the patient is lying on his face with his leg flexed. In this position we can easily control the amount of resistance or assistance to be given and can avoid unnecessary tension on the delicate musculature.

We think we need not give further illustrations of this point.

2. For the same reason—and that is, to avoid unnecessary tension—we carry out the exercise in rather small angles, *e.g.*, in training the hamstring muscles while the patient is lying on his face we give the exercise not from an extended position, but

from an angle of 135 degrees or 120 degrees or even less, according to the power of the muscles.

3. The question of support is especially necessary in exercises of the hip and shoulder muscles. The patient who wants to abduct his leg but cannot do so without aid because of paresis of his gluteus medius, tries to perform a pseudoabduction by lifting the same side of the pelvis with his lumbar muscles, and in so doing does exactly what we wish to avoid—he stretches his paralyzed muscles. In some cases there is danger that an already existing or threatening deformity may be increased when the patient tries to perform a certain movement which he cannot do properly on account of his paralyzed or paretic muscles. In Case IX the right convex dorsolumbar curvature was markedly increased when the patient tried to adduct his left leg while lying supine and with hips and knees flexed.

The complicated mechanism of hand and fingers also requires special consideration as to the most suitable assistance and support in those cases where some muscles are partially paralyzed while others remain intact.

Such careful consideration of the muscular tissue is not necessary in hemiplegia or other forms of paralysis where the peripheral neuron is primarily not affected. The first problem in such cases is to overcome the contracture of the muscles by passive stretching. If this is done early enough and with sufficient perseverance it is possible to avoid permanent contracture, as *Munk's*(13) experiments on monkeys and many clinical observations have shown. Authors vary somewhat in regard to the time best fitted for the beginning of exercises. *Roth*(14) begins one week, *Geigel*(5. a. 6) two weeks after the apoplexy, while *Henschen*(9) advises waiting a few weeks longer before beginning exercises, because they use up too much of the strength of the patient. We personally do not believe that any specified time can be given, each case being considered by itself in relation to the sensitiveness, the amount and character of the contractures, etc.

Such passive movements should be performed, especially in the earliest stages, slowly and easily, in order to avoid injury to

the joints and harmful irritation to muscles and nerves. A quick stretching frequently causes pain and clonus and should be strictly avoided. Temporary application of splints, splinted gloves, or light braces is at times very useful.

Almost always the treatment begins with passive exercises and the conditions encountered in each case determine how early and to what extent the voluntary coöperation of the patient is required. It is obvious that as soon as possible the exercise should have an educational character. In the beginning single muscles or muscle groups are exercised; later on simpler and then more complicated combined movements are to be performed.

Standing and walking exercises, learning a number of useful occupations, such as writing or drawing, and different kinds of play for children, form important parts of the treatment which do not need special discussion.

Gymnastic apparatus, such as Zander's, are of a somewhat limited value especially in early cases, because most of them need a certain amount of control on the part of the patient. They are, however, of much use for general tonic exercise, which can be given with good dosage and perhaps more rhythmically than by a manual treatment. Those apparatus which are driven by electric power or by the centrifugal power of a turning wheel, and pendulum apparatus are of great value. For the individual case apparatus are not necessary, but they are indispensable for the conduct of a large hospital clinic.

The following special exercises* have been found useful:

1. Symmetrical exercises.

These are of especial value in cases of paralysis of one side, as in hemiplegia. The value of this method may be understood when we consider the importance of symmetrical stimulation for simple movements. For instance, we find it easier to move the hands or the arms in symmetrical circles or figures than in asymmetrical ones. One can easily demonstrate this fact when in such cases we allow the patient, who is not trained, to do symmetrical exercises with both arms. The patient who can

*For detailed description of these special exercises see Goldscheider and Jacob, "Handbuch der physicalischen Therapie."

perform a simple movement of his healthy hand without any difficulty shows a certain stiffness of all his muscles when we have him do this movement with both hands at the same time, an observation which is the more striking the more complicated the movement we have him do. The right selection of such symmetrical exercises also favors the desired general effect on the circulatory organs as well as on the lungs when we combine them with the rhythmical breathing exercises.

2. Kineto-therapeutic baths are of the greatest value in all cases of paraplegia, not only in those of a spastic type, but also in earlier cases of peripheral polyneuritis, anterior poliomyelitis, and similar forms. The explanation of the good effect is that the specific buoying power of the water allows the patient to move the paralyzed limb with a minimum expenditure of energy. We also know the sedative and antispasmodic effect of the warm water bath and must not underestimate the general effect of its application.

The period during which treatment should be continued varies with the special features of the individual case. In the case of a paralytic foot which can be easily corrected by a brace it would not be justifiable to advise a treatment which requires a great amount of time and expense, while in cases of any extensive amount of paralysis, especially of the upper extremities, treatment should be continued until the possibilities of improvement are reasonably exhausted. This, however, may often require a very long time. In cerebral paralysis a treatment which lasts for years is frequently indicated. We tell our patients, particularly those who have been paralyzed for a long period, not to be impatient if they do not see a considerable improvement during the first two or three months. We make notes of the movements they are able to execute in the beginning, the height to which they can reach with the hand, the power of the fingers, etc., and compare these with the result after several months. This encourages the patient and shows us what is to be expected in the future. It is only a relatively small part of paralyzed persons who can enjoy treatment in hospitals and special institutions. But a great many useful exercises can be learned by the use of a

little common sense on the part of the physician and coöperation on the part of the parents if the right directions are given. Our work in the hospital has consisted to a large extent of lessons given to the patient or his relatives. We give them detailed prescriptions for the exercises, but what is perhaps of greater importance is that we try to teach them the right spirit and understanding of the treatment. We teach them to understand the amount of exercise the patient can do, which varies greatly on various days and with increasing improvement. We especially emphasize that they must not overexert themselves. Too much exercise may do more harm than no exercise at all, in that it may cause nervousness and lack of interest on the part of the patient and may nullify what we have gained. With the right understanding of its spirit, however, this exercise treatment may not only be expected to improve the actual physical condition of the patient and make him a more useful member of society, but will also, if rightly administered, open up a vista of hope to these discouraged individuals and add largely to the happiness of their lives. As we have said before, we believe this latter consideration alone would make it an end in itself.

REPORT OF CASES.

The total number of paralytic patients who have been under treatment from April, 1908, to March, 1911, amounts to 149.

Among them there are:

- a. 53 cases of anterior poliomyelitis.
- b. 49 cases of hemiplegia.
- c. 11 cases of cerebral infantile paralysis.
- d. 10 cases of peripheral paralysis.
- e. 9 cases of obstetrical paralysis.
- f. 5 cases of polyneuritis.
- g. 8 cases of paraplegia.
- h. 4 miscellaneous cases.

In each division there are a number of cases which cannot be considered as being of any value for the statistics for various reasons. Either the patients have been treated only once or a

few times so that any conclusions as to the benefit of the treatment cannot be made, or the disease was in such an early stage that a marked improvement could be expected anyway, or the cause of the disease was of a specific character so that improvement by specific treatment was to be expected. Also there are a number of cases which are not considered because of a lack of exact records. The work dealt with in this paper has been developed with special attention only since about the last half of 1909. Also in the previous period treatment has been given on similar principles as described above to a number of cases but we have not always laid special attention on the exact records, so that several cases could not be considered in this paper which have shown, as we remember, a distinct improvement.

REPORT OF CASES.

Diagnosis	No.	Duration of paralysis		Not or very little improved	Somewhat improved	Distinctly improved	Very markedly improved
Spinal infantile paralysis.	20	Less than 6 months.....	2	.....	1	1	.....
		6 months.....	4	.....	.....	3	1
		6-12 months.....	7	2	3	2	.....
		More than 12 months.....	7	.....	2	5	.....
Hemiplegia.....	16	Less than 2 months.....	5	1	1	1	3
		2-12 months.....	1	.....	.....	.....	.....
		More than 12 months.....	10	1	2	5	2
Infantile hemiplegia.....	5	.....	.....	2	1	1	1
Peripheral paralysis.....	6	Less than 2 months.....	4	1	1	1	1
		More than 12 months.....	2	.....	1	1	.....
Obstetrical paralysis.....	5	.....	.....	.....	3	2	.....
Peripheral polyneuritis...	3	More than 12 months.....	.....	1	.....	2	.....
Paraplegia.....	5	.....	.....	2	.....	1	2
Multiple sclerosis.....	1	.....	.....	.....	1	.....	.....
Lateral amyotrophic sclerosis.	1	.....	.....	.....	1	.....	.....
Little's disease.....	1	.....	.....	.....	.....	1	.....
Paralysis due to lead poisoning.	2	.....	.....	.....	.....	1	1
Total.....	65	.....	.....	10	17	27	11

The table brings a statistic of those cases which have been found worthy of consideration. It does not need further explanation. However, attention may be called to those cases which came under our treatment a considerable length of time after the onset of the disease. In some of them the results were very satisfactory, at times even striking.*

In the following some of the illustrated cases are reported:

CASE I.—Infantile paralysis. C. F. E., male, twelve years of age, had anterior poliomyelitis three months ago. When brought to the clinic he showed very painful contracture of the right knee of 150 degrees and a slight contracture of the right hip with a slight tendency of the knee to subluxation. All the muscles of the hip were present but weak, and passive motions were free except full extension. Passive flexion of the knee was free, but both active flexion and extension were very weak. The foot was nearly entirely paralyzed and useless.

During the first few weeks the painful contractures of the hip and knee were eliminated by gentle manipulations and massage, the leg being kept on a ham splint. Then gradual exercises were started and carried out at home after two weeks' instruction in the clinic. Considerable improvement was shown in five months. All the hip motions were possible and rather strong, except abduction and rotation, which were still weak. The knee was passively freely movable. The extension was good and strong and a slight amount of active flexion was possible. The foot was held in good position and the few preserved muscles have become stronger, but no other muscles have developed. With a varus shoe patient walks very well.

CASE II.—Infantile paralysis. J. B., boy of three years, with anterior poliomyelitis since ten months. When seen first there was complete paralysis of the entire left leg. After treatment of five months' duration, twice a week, at the clinic, besides home exercises, the patient is now able to stand alone and to walk a few steps without assistance.

CASE III.—Infantile paralysis. E. H., boy of six years, with acute anterior poliomyelitis in June, 1909. Both shoulders and upper arms extensively, hands and back partially, paralyzed. In the fall of 1909 a spring back brace was made which supported the weak and slightly curved back. Exercise treatment

* More than one year has passed since this paper was finished. In the meantime, a number of cases has been treated with the above-described methods both at the hospital and in private practice. A report of those cases is planned.

was started in December, 1909, after previous treatment with massage and electricity. When first seen practically no active motion of either shoulder-joint was possible. The patient could bend the elbow but could not raise his hands to his head. Any attempt to move the arms considerably increased the deformity of the back. Exercise treatment was carried on until June, 1910, with distinct improvement, especially of the right shoulder muscles, so that patient at least can hold his right arm elevated. The curvature of the back has nearly entirely disappeared and the motions become fairly strong. The result was chiefly obtained by training those muscles which were not fully paralyzed.

CASE IV.—Infantile paralysis. J. B., boy of five years. He had anterior poliomyelitis in June, 1909. When I first saw him in February, 1910, the right leg was completely paralyzed except the upper half of the rectus femoris and the tensor fasciæ latæ. There was no active motion of the knee or foot. Both feet were somewhat contracted in equino varus position. The left leg had also been paralyzed but was entirely recovered with the exception of the contracture of the foot. Exercise treatment has been given since with a distinct improvement. The muscles which were preserved, but very weak, are now fairly strong, and within the last six months distinct, though very weak, action of the flexors and extensors of the knee has returned. The contracture of the feet is eliminated and the boy walks quite well with a simple caliper splint.

CASE V.—Infantile paralysis. M. F., girl of nine years. Had anterior poliomyelitis in fall of 1907 and came to the Out-Patient Department in September, 1908, on account of her poor attitude. A spring back brace was measured for, and in December, 1909, she was sent to the Medico-Mechanical Department for exercises and massage. Although fifteen months had passed since the onset, she improved under fifty treatments so that she was able to hold the arms vertically elevated, which she could not do in the beginning. The improvement was largely due to a strengthening of the preserved muscles.

CASE VI.—Infantile paralysis. N. O'B., woman of twenty-four years, who had anterior poliomyelitis in July, 1909. She was sent to the Medico-Mechanical Department in January, 1911.

When first seen the following notes were made: "The patient can lift up her left arm actively only a few degrees. The biceps and triceps are very weak; active pronation is not possible; the forearm is constantly held in full supination. The extensors of the fingers are rather weak."

Under a nearly regular treatment of two months' duration, she improved noticeably; the flexors of the forearm, the triceps, and the pronator muscles showed considerable improvement. Now, two months after beginning the treatment, she pulls about 4 pounds with the flexors of the forearm and 5 to 6 pounds with the triceps from a right angle position. She turns the forearm about 60 to 80 degrees towards pronation. In lying, she holds her arm vertically elevated for a short while, which she could not do before. The deltoid has not shown any signs of recovery, and the case might be suitable later on for a transplantation of a part of the trapezius upon the paralyzed deltoid.

CASE VII.—Infantile paralysis. J. W. P., male, sixteen years of age, had partial paralysis of his trunk, pelvis, and both legs, since November, 1909. The cause was probably a transverse myelitis, but differential diagnosis of anterior poliomyelitis was considered in the Nerve Department. A short period of total paralysis was followed by gradual improvement, which has continued up to the present time.

In January, 1911, when first seen in the Medico-Mechanical Department, the patient showed the following symptoms. He walked with very marked lack of support, very much like patients with double congenital hip dislocation. In standing on one leg he was not able to balance the body in a normal manner, but showed a marked Trendelenburg's symptom. The forward bending of the body was possible, but the patient could not hold himself without help in that position and had great difficulty in raising up his body again. He could hardly bend his body sideways. The movements of the legs were all possible, but very weak and unsteady. Both feet were markedly pronated and flattened.

Under a nine weeks' exercise treatment and massage the patient has been markedly improved, as he says himself. His gait is much better. He can balance his body fairly normally when standing on one leg. He raises up his body after stooping forward rather easily and can hold himself in a stooping position without assistance. The sideward movements of the trunk are nearly normal. His legs are moved much easier and are rather steady. He has procured plates for his deformed foot, which correct them somewhat.

The patient is still under treatment. With this marked improvement which has shown in two months, the prognosis of a good final outcome seems very favorable.

CASE VIII.—Infantile paralysis.(?) M. E. J., woman of

twenty-nine years, who has an extensive paralysis of the right shoulder and upper arm, which was said to be due to dislocation of the humerus when two years of age, but is more probably due to an anterior poliomyelitis. Patient came to the hospital on account of pain caused by pressure of the head of the humerus on the nerve plexus. The shoulder-joint was extremely loose and she had no use of any of the muscles of the upper arm. Also the flexors of the elbow were completely paralyzed. The question of an arthrodesis was discussed, but exercise treatment recom-



FIG. 1.—Case VIII. Shows the patient with the elbow flexed.

mended for the beginning, although the patient and the attending physician were very sceptical as to the result. Distinct improvement was noticed after a few months and has advanced since. The patient has learned a number of motions which she has never been able to do since she remembers. She can now flex her elbow to a right angle, chiefly by means of the supinator longus, and can assist with the right hand in binding her skirts and in arranging her hair, which was previously possible only by supporting her elbow. In lying down she can balance her arm in a vertical position.

Figs. 1 and 2 show the patient holding her right arm in posi-

tions which enable her to use it for fastening her skirts and fixing her hair. Of course she cannot lift the right arm alone up to the head, but she can hold it without further support. Further steps as an arthrodesis, which now would give a much better chance, since the shoulder muscles are much stronger, or transplantation of muscles have not yet been decided upon.



FIG. 2.—Case VIII. Shows the patient with the hand lying on the head.

CASE IX.—Infantile paralysis. H. D., boy of fourteen years, who had anterior poliomyelitis three and one-half years ago. I have seen this patient only lately for a few weeks, but I shall give a brief report because of the important fact that by a constant and very thorough treatment with exercises, massage, and electricity, as well as by supportive appliances, he has shown a continuous improvement which is apparently still going on. The patient has been for a long time under the care of Dr. E. G. Brackett, who has kindly allowed me to give this report. It was a very extensive paralysis of the left arm, both legs, and many trunk muscles. One year after the onset the left arm and hand showed only slight traces of function, while now the flexors of the hand and arm, the flexors and extensors of the forearm, and some of the scapula muscles are active, though rather weak. The

same slow improvement within the second and third year after the onset was noticed in the back muscles. With the energy of the patient and his mother, and the skill of his masseur, we hope that improvement may go on further.

GROUP B.

There are forty-nine cases of hemiplegia. Thirty-four are not considered for the reasons mentioned above. Of the remaining fifteen cases, five showed no satisfactory physical improvement even under a long treatment. All of them were mentally much affected. In the cases there was improvement which was very marked. Among these are the following cases:

CASE X.—Hemiplegia. A. P. R., a man of twenty-two years, who showed a severe left sided hemiplegia following an accident four weeks previously. When first seen he was walking with difficulty and showed a very marked contracture of the fingers. Hardly any active motion in fingers and forearm; little active motion in shoulder and elbow. Under exercise treatment he improved rapidly and reported to us in six months after the onset that he was again able to do his professional work as an artistic swimmer.

CASE XI.—Hemiplegia. I. A. S., colored man of fifty-one years, with cerebral hemiplegia since two and one-half years. During a treatment of three months patient is subjectively and objectively very much improved. He says the exercise treatment did him more good than anything he has done before. He can now use his right hand for carving his food, buttoning his clothes, brushing his hair, and similar occupations which he was not able to perform previously.

CASE XII.—Hemiplegia. Mrs. J. E. F., woman of forty-three years, who suffered from left sided hemiplegia for four and one-half years. The left hand has been all this time almost entirely useless, and for two years there had been no improvement. In the beginning of the treatment the patient was able to bring her hand to the face and with great difficulty to touch the hair. Active extension of the fingers was possible only with the wrist flexed. Any complicated motion showed considerable lack of control. The patient walked with much limping and rather unsteadily.

After eight months of treatment considerable improvement was noticed in regard to lifting the left arm, in complicated motions of the hand and fingers, and in walking. She is now able to use

her left hand in fixing her hair, she can hold a pitcher, and can pick up her handkerchief. She holds her fork with greater ease than previously. Improvement is still going on and the patient, who is very much satisfied with the result, is anxious to continue the treatment for a much longer period.

CASE XIII.—Hemiplegia. A. S., man of thirty-seven years, who was affected with hemiplegia four months ago. When first seen in April, 1908, patient could raise his left hand up to the chest, but very slowly and with great difficulty; hand and fingers were strongly flexed. Practically no active motion was possible in the shoulder and there was little in the elbow and the hand. Passive motion was much limited, due to marked spasm of the flexor muscles. In the left leg active motion of the knee, abduction of the thigh, and dorsal flexion of the foot were impossible, and walking was very poor.

With forty-four treatments in 1908 patient improved distinctly, the spasm of the muscles was much reduced, and the active motions better.

In 1909 the patient was not able to come for treatment, but exercised at home in the same way as in the hospital.

In 1910 he returned and had treatment for several months, during which time the improvement went on.

When last seen he was able to raise his arm up to nearly 150 degrees and abducted it to 90 degrees. The motions of the elbow are fairly free, though spasm is still present. With the elbow held at a right angle, supination and pronation are practically free. Dorsal flexion on the wrist is possible, but with the fingers flexed. The function of the fingers is fairly good. Hip and knee motions are free and strong. The foot motions are about one-half limited. Patient still limps distinctly, but much less than in the beginning and stands well on either foot. He says that he is able to carry a hundred pound sack of potatoes upstairs on his left shoulder.

CASE XIV.—Hemiplegia. J. C., male, age forty, right-sided hemiplegia for four years. When he entered the clinic the right arm was entirely useless, there being only a slight amount of abduction in the shoulder-joint and a few degrees of flexion in the elbow. The forearm, hand, and fingers, were completely motionless and contracted. The patient walked with a marked limp and very slowly, and had great difficulty in going upstairs. In standing he could flex his thigh to about 60 degrees, but could not abduct nor hyperextend it and had very little rotation. There was no active motion of the foot.

He has had exercise treatment for a few months only and yet the results obtained are already fairly satisfactory, and the patient is very much pleased. The results show in better active and passive mobility of the shoulder and elbow, and although the hand is still completely paralyzed* the fingers show distinctly less contractures. The patient can now flex his thigh to a right angle and has good abduction and hyperextension and better rotation. Also the motions of the foot have partially returned.

CASE XV.—Infantile hemiplegia. D. B., a girl of twelve years, with left sided hemiplegia caused by an obstetrical trauma. A marked improvement has been noted since the beginning of the treatment, which has lasted now for eight months. The patient is now able to use all five fingers of the left hand fairly easily in playing the piano and can stretch seven notes, while before the treatment she could only play with the first and second fingers with much difficulty. She can also use her hand for sewing. The spasmodic symptoms have disappeared to a great extent, and the accompanying movements of the mouth and the right hand while doing voluntary movements with the left hand, which were bothering her very much previously, have almost entirely ceased. In the beginning she turned her left leg considerably inward in walking and sitting; now she walks much better and has more control of her left leg. She still turns it inward, but to a much less extent, and in sitting holds the leg in a rather natural position, which she was not able to do before.

CASE XVI.—Traumatic paralysis of the brachial plexus. E. G. N., man of sixty-two years, who had a paralysis of his right arm due to an injury of the brachial plexus in consequence of a dislocation of the humerus. The dislocation was reduced and the arm fixed for some time. The arm became nearly totally stiff in the shoulder, hand, and fingers, and partially limited in all other motions. A year and a half after the accident an exploratory operation was done in the Surgical Department. No lesion of the plexus was seen, however.

After recovery from the operation, exercise, massage, and electricity were applied with a result which is rather poor when we compare the paralyzed arm with the normal arm, but which shows that some improvement can be obtained even in such serious cases. The difficulty in this case was the combination of almost complete paralysis and almost complete stiffness. He has been improved now in such a way that he can use his arm for

* In the meanwhile the flexors of the fingers have regained some voluntary function.

some things. With his fingers he can grasp light things as newspapers, a pencil, a fork, etc. He is able to bring a bit to his mouth, although in daily life he does it with the left hand. The movements of the right shoulder have become distinctly more free than before.

CASE XVII.—Spastic paraplegia. C. P., a boy of seventeen years, suffering from spastic paraplegia. The patient had frequent attacks of muscular rigidity and difficulty in locomotion during the last three years. The last attack began three weeks before he entered the hospital and increased rapidly so that he was not able to stand or walk. He also showed slight ataxia of the arms. Under gentle passive and later passive-active exercises he improved quickly. Now, about a year and a half after the onset, he walks normally. About a hundred treatments have been given during this period.

CASE XVIII.—Amyotrophic lateral sclerosis. E. C. R., man of forty-four years, who developed trouble in 1899 after falling from a bicycle. For two weeks after the accident he was apparently well; then he noticed weakness in his right arm and leg which slightly increased for some time. In 1904 he worked very hard under a severe mental strain. At that time he fell down stairs and became unconscious. After this the weakness rapidly increased and was also noticed in his left arm and leg. For four years his right arm has been entirely useless and held extended with an extreme degree of rigidity. His left arm and hand also show a great deal of rigidity and lack of function. His shoulders are drawn forward and upward. He has a very marked spastic, ataxic gait and has great difficulty in walking. Walking upstairs is impossible. The patient has been confined to his wheel-chair for years and it is now three years since he has been able to bring his right hand near to his face.

On account of the combination of the enormous rigidity of many muscles, especially the pectorales, with stiffness of many joints, and paralysis of many muscles, the prognosis as to any improvement was made with great caution. Merely as an attempt, the patient, who lived out of town, was brought to the hospital to be treated twice daily at the Medico-Mechanical and Hydrotherapeutic Departments. He improved, however, to such an extent objectively as well as subjectively, and also in regard to his general health, that he continued the treatment after leaving the hospital at the end of three months. He had learned to use his left hand much better and even to do things with the right hand which he could not do before. He walked a

great deal better, though his gait is still far from being normal. He learned walking up- and downstairs with the help of another person. Encouraged by this improvement, we thought it might be possible to relieve the strong spastic contracture of his right pectoralis and so to give his right arm better active motion by an operation. A myotomy was done in the Orthopedic Department, but, unfortunately, a few days after the operation a thrombosis of the left leg developed, although the wound healed primarily. This fact has prevented him, up to the present time, from continuing exercises.



FIG. 3.—Case XIX. Shows the patient holding up his right arm with the fingers extended. Neither position was possible before the treatment.

CASE XIX.—Little's Disease. F. R., boy of eleven years, who has a spastic paralysis of the right arm and both legs, due to a trauma during delivery. He was one of twins, the other child being born dead. The case has previously been under the care of Dr. E. G. Brackett, who sent the patient to the Medico-Mechanical Department in October, 1910.

By about fifty-five treatments given during five months, the improvement, which was very slow before, became more rapid and the boy has learned a number of things which he could not do before. Both his parents emphasize the marked improvement

in regard to his gait and in the use of his right hand, which was entirely useless before. When seen first the boy was not able to open his fingers at all, which he can do now (see Fig. 3), although still with the wrist somewhat flexed. The contractures are so much less that his mother can now put on his mitten in a normal manner and not over his flexed fingers. Furthermore, he can now grasp a cane and lift it easily (see Fig. 4). He holds little things in his right hand and can dress himself. He has also

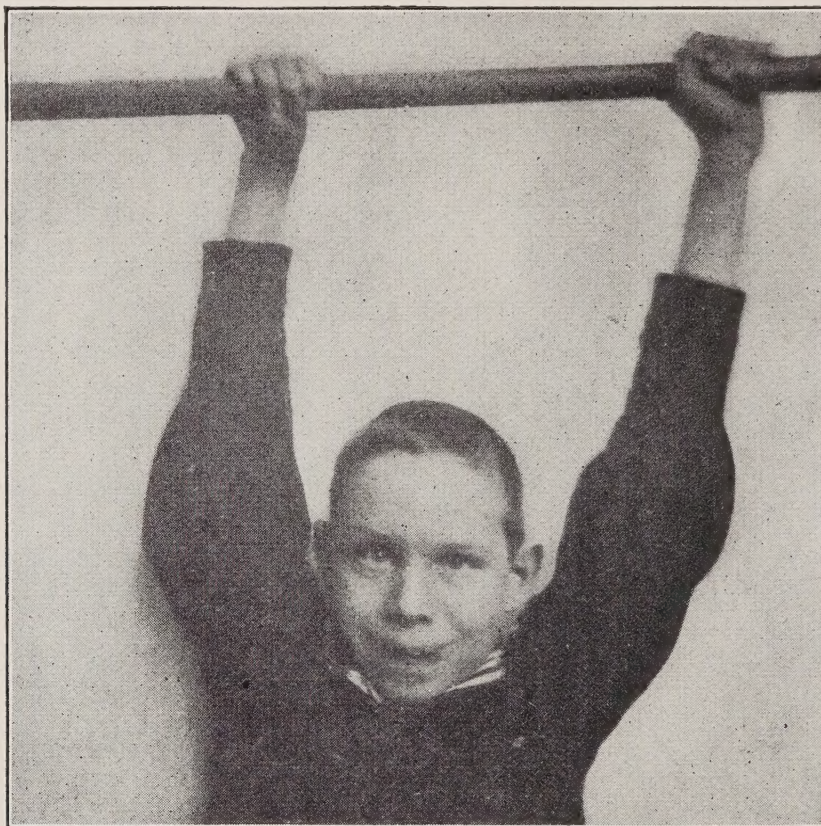


FIG. 4.—Case XIX. Shows the patient holding up a cane with both hands. Before the treatment neither grasping a cane with the right hand nor full elevation of the right arm was possible.

learned to bathe himself alone and to walk alone up- and down-stairs. He walks much more easily and steadily and has much better control so that he does not fall so often as he used to. This winter he has coasted a great deal, which he never could do before.

CASE XX.—Lead poisoning. W. M., male, age forty-four years. Symptoms began three years ago. He found himself unable to control his fingers and had trouble in milking and in lifting his milk cans. Two months later he noticed difficulty in lifting his feet. The diagnosis was made of progressive muscular atrophy, but somewhat later was corrected to paralysis due to lead poisoning, which was probably due to water pipes. Under treatment



FIG. 5.—Case XX. Shows the patient's dropped hands before the treatment



FIG. 6.—Case XX. Shows the patient holding his hands somewhat actively extended, after a treatment of three months and a half.

by his physician the paralysis disappeared and patient was able to resume his work. In the fall of 1909 he became worse again and had to give up his work. In February, 1910, the drinking water which he used was examined and found to contain an appreciable amount of lead from a waterpipe. He stopped drinking this water and improved slightly until September, 1910, when his improvement came to a standstill.

In October, 1910, he was taken to the hospital and showed the following symptoms. The muscles of the shoulder girdle,

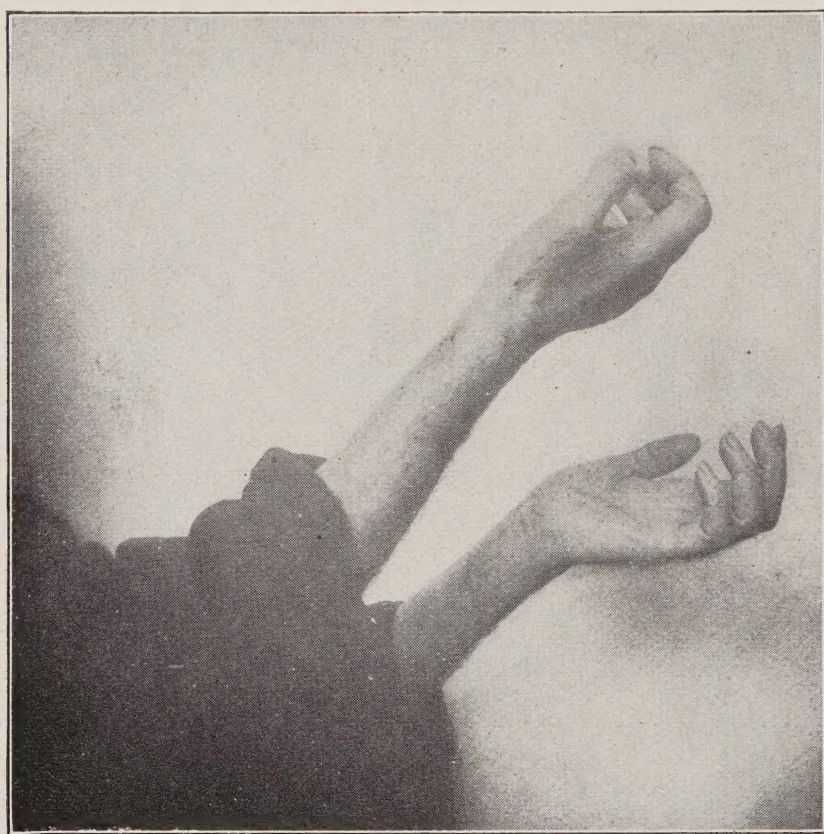


FIG. 7.—Case XX. Shows the patient holding his arms in supination with the hands somewhat extended, after a treatment of two months and a half. Four weeks later full palmar flexion of both wrists was possible.

the flexors and extensors of both forearms, and supinator longus are weak but active. There is a complete paralysis of all muscles of the extensors of the wrist and fingers and a nearly complete paralysis of the flexors of the wrist, while the fingers can be actively flexed a few degrees. In fact, both hands hang down flabby and lifeless and are entirely useless. Furthermore, all muscles below the knee are completely paralyzed.

Under treatment, which was done with especial care in order to avoid stretching of the flabby muscles, the patient improved slowly but rather steadily. One after the other of the para-

lyzed muscles returned, and now after a four months' treatment which has been given twice a day, about all the muscles have regained some power, although some of them are still very weak. As the illustrations show, the patient is now able to raise his hands and hold them in a fairly extended position in both supination and pronation. With a great deal of energy the patient has learned to write. We gave him at first in December, 1910, a very thick and soft pencil with which he began to draw simple

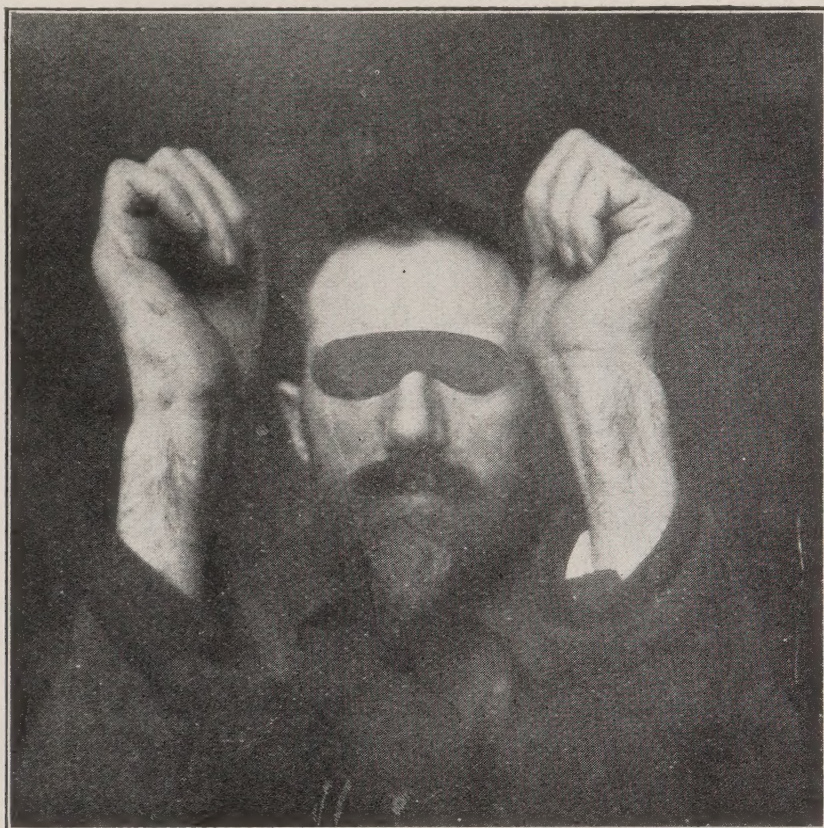


FIG. 8.—Case XX. Shows the patient holding his forearms upright with the hands balancing after a treatment of two months and a half.

lines on a somewhat rough paper. In February, 1911, he was able to write with ink and with a simple penholder in a fairly accurate manner, though still very slowly. We also started walking exercises and we made him a valgus brace, with which he walks fairly well when assisted by another person. The treatment had to be stopped in the clinic, but will be continued in his home by his relatives, whom we have thoroughly trained (see Figs. 5-8).

CASE XXI.—Multiple sclerosis. Girl of seventeen years who had suffered for about four or five years from lack of coördination due to multiple sclerosis, and had been growing worse for some

time before she came for treatment. During five months she had fourteen treatments in the clinic and took home exercises besides. She improved markedly and gained much better control of active and especially symmetrical movements. No conclusion as to the final result, however, is possible, since the patient died a short time afterward from scarlet fever.

CASE XXII.—Obstetrical paralysis. Five-year-old girl. The statement was made by the attending physician that nothing could be done. Although the paralysis was very severe indeed, I recommended exercise treatment which has now been given for about sixteen months, with a distinct though slight result. The child, who used to do everything with her very well developed right hand alone, has now learned to make a certain use of her left hand. She has learned to hold and grasp little things, she has learned knitting, and she can strike the piano keys with the index finger. But what seems to me of greatest importance is that her interest is so aroused that she herself tries to develop her left hand and arm by exercises with the assistance of the right hand.

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DISCUSSION.

DR. BRADFORD, Boston.—The results given in this paper show the great worth of long continued systematic exercises. The gain to be expected at times is marked. These cases are all so hopeless, unless something of this kind is done, that every means possible should be tried; and this is one means that has always helped to produce improvement months and months after the onset of the paralysis.

DR. OSGOOD, Boston.—I should also like to bear witness to the value of the work of Dr. Bucholz. It emphasizes the importance of his individual careful pursuit of his specialty. We see these cases in a clinical way, many of them being ones that we have been quite discouraged about and have turned over to him largely because we did not know what to do with them. The results, though very slow, have been among the most brilliant of any cases of these paralyses that we have known. It is a work that involves a detail and a patience that are enormous, but the results are quite worth it.

DR. TRUSLOW, Brooklyn.—I too want to bear testimony to the fact that it does take time and trouble but that much may be accomplished by patient effort. Yet I also wish to sound a warning that if deformity is present, this should be first corrected by mechanical means. One should not expect that muscle traction can be really beneficial in such cases. The deformity should be corrected before the stretching exercises are undertaken.

DR. CONE, Baltimore.—I should like to refer to a case in this connection. The patient required exercise to produce results. There was paralysis of the throat's involuntary muscles, and she went to various men for some years in the hope of obtaining relief. A careful internal medical man took care of her, and exercise of the voluntary muscles was carried out by him. When he took charge of her, she was not able to use the throat at all, and had to be fed by means of a stomach tube; but after some months of exercise, the voluntary muscles were trained to take the place of the involuntary ones in the act of swallowing. She had practically a new throat.

DR. BUCHOLZ, closing.—I want to make only one point, and that is in regard to overexertion of the patient. This has been frequently allowed, in my experience, by even well-trained men, and we have seen some cases in which bad results were caused by it.

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The American Journal of Orthopedic Surgery

THE OFFICIAL PUBLICATION OF THE
AMERICAN ORTHOPEDIC ASSOCIATION

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PUBLISHED FOR THE ASSOCIATION BY
P. BLAKISTON'S SON & CO.
1012 WALNUT STREET ————— PHILADELPHIA